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Study of Phytotoxic effect of textile wastewater on seed germination and seedling growth of *Triticum aestivum*

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ABSTRACT:
The paper presents an investigation conducted in order to study the phytotoxic effects of textile wastewater on germination and early growth of *Triticum aestivum. Triticum aestivum* belongs to family Poaceae and commonly referred to as common wheat, bread wheat. Sixteen samples were collected from Bagru (Hub of small scale textile industries) Rajasthan and were analyzed for various physic-chemical parameters including pH, TDS, EC, Chloride, hardness etc. the wastewater were rich in hardness, chloride etc with pH ranges from 2.0 to 8.12. Parameters studied in case of *o. sativa* includes germination percentage, percentage phytotoxicity, Tolerance index, relative length of germinated seedlings, fresh weight and dry weight of seedlings. Germination percentage and seedling growth shows considerable reduction as compared to control with relative germination percentage reducing to 36.66% as compared to control with 100% germination percentage. Similarly the wastewater showed inhibitory effect on seedling growth with minimum length of root up to 1.03±0.1 cm and shoot up to 0.74±0.05 cm in contrast with control with 6.48±0.01 cm root length and 5.65±0.04 cm shoot length. Effluent with lower concentration showed seedling growth higher than the control. The findings indicate that textile wastewater being rich in dissolved solids reduces the energy supply through anaerobic respiration causing retardation of growth and development of seedling. Similarly increase in phytotoxicity percentage and decrease in tolerance index and vigour index was observed. Therefore use of wastewater for irrigation purpose cannot be permitted without treatment.

KEYWORDS: Bagru, Phytotoxicity, physicochemical, *Triticum aestivum*

INTRODUCTION

Textile dyes are chemicals of complex aromatic structures designed to resist the impact of detergents, sunshine and temperatures [1]. There are more than 10^5 kinds of commercially available dyes with over 7×10^5 tones of dyestuff produced annually [2]. The inefficiency in dyeing processes has resulted in 10-15% of unused dyestuff entering the wastewater directly [3]. All textile industries are not equipped with wastewater treatment systems; as a result most of the untreated water is discharged as it is into nearby water bodies. Wastewater affects nearby soil and in recent past, irrigation practicing with wastewater has emerged [4]. resulting in reduction in nutritional quality of crop [5, 6], moreover presence of heavy metals in textile wastewater produces antagonistic affect on plant nutrient uptake [7]. Another threat includes not only alteration of soil chemistry but also changes in bacterial and VAM population in addition to enhancing the intrinsic endurance of these microbes to different metal ions present in their microenvironment [8]. Therefore it is necessary to study the impact of these effluents on crops including vegetables.

The present research was carried out to study the impact of textile dyes on seed germination and seedling growth of drought resistant variety of *T. aestivum.*

STUDY AREA:

Bagru, a small town in Rajasthan (India) about 35 km south-west of Jaipur on Jaipur- Ajmer road (26^O 49' 0" North, 75^O 33' 0" East) is famous for work of block printing and is home of a large number of small scale dyeing industries. . Bagru possess a wide history of practicing dyeing and printing dated back to 350 years. The locals of Chippa Mohalla beside the Sanjaria River are a real cynosure where more than three dozen families can be seen busy with dyes and blocks.

The craftsmen of Bagru have preserved the traditional crafts for centuries. With magnificent history of dyeing and printing work, this region does not possess much wastewater treatment plants.

MATERIALS AND METHODS

Sampling is one of the objective, affects results most. Samples were collected in cleaned acid washed plastic bottles. Sixteen different water samples were collected using standard methods (Fig 1). The samples were stored at 4^OC to avoid changes in their characteristics. Samples were comprised of textile wastewater from various small scale textile units and few groundwater samples. Seeds of *T. aestivum* HD 2932 were obtained from Indian Agriculture research Institute, PUSA, New Delhi. The healthy and uniform seeds were selected and were thoroughly washed with running tap

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water, were surface sterilized with 0.1% $HgCl_2$ and thoroughly rinsed with distilled water. 10 seeds were placed equidistantly on soaked filter paper in petriplates. The seeds were irrigated with equal volume of effluent samples and seeds irrigated with distilled water were taken as control. The number of seed germinated was recorded after 48 hrs. The growth parameters like plumule length, radical length, and fresh weight of seedlings were recorded after 7 days and dry weight was recorded after keeping them in hot air oven at 60^{O}C for 24 hours.

The relative germination was calculated using the formula [9]

$$\textbf{Relative Germination} = \frac{\text{Number of germination in the extract} \times 100}{\text{Number of germination in the control}} \qquad \text{(Eqn. 1)}$$

The percentage of phytotoxicity was calculated using the formula [10]

$$\textbf{Percentage phytotoxicity} \quad \frac{\text{Radical length of control} - \text{Radical length of test} \times 100}{\text{Radical length of control}} \qquad \text{(Eqn. 2)}$$

The Tolerance index of seedlings was calculated by the formula [11]

$$\textbf{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}} \qquad \text{(Eqn. 3)}$$

The Vigour Index of the seedling was calculated by using the formula [12]

$$\textbf{Vigour Index} = \text{(MRL+MSL) PG} \qquad \text{(Eqn. 4)}$$

MRL = Mean Root Length; MSL = Mean Shoot Length; PG = Percentage Germination

The data observed in the experiment was statistically analyzed for the calculation of standard of error (S.E.) [13]

RESULTS AND DISCUSSION

The physicochemical analysis of effluent samples and correlation between them is given in **Table 1**and **Table 2** respectively. Analytical results of different parameters and effect of effluents have been discussed:

(A) Physicochemical Analysis:

pH:

Although no health based guideline is proposed for pH but sometimes, eye irritation and other skin disorders are associated with values of pH greater than 11[14]. The lower values will also lead to the similar effect [15]. The pH of collected water samples was between 7.5 to 7.8, showing the water is slightly alkaline, because in most of the steps alkali nature detergents are used in large quantity. The result coincides with findings of [16**,** 17] in their studies on the physicochemical characterization of textile wastewater. Exception was sample W13 wastewater of harda dye which has shown the pH 4.46, indicating that it must be acidic in nature.

Total Dissolved Solids:

Total Dissolved Solids comprise mainly of inorganic salts (bicarbonates, chlorides and sulfates of calcium, magnesium, potassium and sodium) and small amounts of organic matter that are soluble in water. Therefore TDS concentration is the sum of cations and anions in water. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is not generally considered as primary pollutant, it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants[18]. The value of TDS ranges from 2320 to 9840, indicating the presence of high amount of inorganic salts.

Electrical Conductivity:

Electrical conductivity or specific conductance is a measure of a material's ability to conduct an electric current. Salty water conducts electricity more readily than purer water. The electrical conductivity of fresh water rivers should be 0-0.08 mS. the electrical conductivity of water samples calculated ranges from 3.57 to 5.80 mS. Electrical conductivity depends on type and amount of cloth processes however the result coincides with the findings of [19], exception being the electrical conductivity of synthetic red dye wastewater as it is an acid dye wastewater.

Hardness:

Hardness of analyzed water samples was within the range of 186 (mg/L) to 1740 (mg/L). the maximum limit of total hardness recommended by WHO and American Public Health Association (APHA) are 500 and 250 mg/L respectively. Samples evaluated possess hardness within the permissible limits according to APHA but not WHO. The findings are similar to [16, 17, 20]. Low hardness value is the result of water softening steps carried out in textile industries.

Salinity:

Salinity is the measure of all the salts dissolved in water. Salinity is usually measured in ppt (parts per

thousand). The average ocean salinity is 35 ppt and the average river water salinity is 0.5 ppt or less. This means that in every 1000 g of sea water 35 g are salt.

High concentration of salt poses hazards for the environment as well as affecting agriculture and infrastructure and therefore wider economy.

Chloride:
Chloride at concentration extending beyond 250 mg/L can leads to corrosion and may affect palatability. Chloride content exceeds the permissible standard by WHO and Indian Standard Specification for Drinking Water. The chloride content of the samples ranges from 284-4650.5 mg/L. Chloride in textile wastewater also increases due to water softening process of when sodium chloride is used to recharge softeners. Moreover, some chlorides containing compounds are also used in the wet processes of cloth [21]**.** Conclude textile industries are one of the most polluting industries. The results are in agreement with the previous findings of [22].

(B) Effect of Effluents:
Seed Germination:
The laboratory experiment on *T. aestivum* showed an inhibitory effect of industrial effluents on seed germination and its early growth as compared with control (Table 3).

The *T.aestivum* seeds irrigated with textile wastewater showed significant decrease in seed germination and seedling growth parameters that is root length, shoot length, fresh weight of seedling and dry weight of seedling as compared to control. Minimum germination (36.66%) was recorded in seeds irrigated with highly concentrated wastewater of Harda dye (W13) as compared to control (100%) (Table 3) followed by W7 (46.66%) and W1 (50%). Samples W7 and W1 were wastewater of Kashish dye and Effluent of various textile dye respectively. Samples with maximum inhibitory effects were observed as more concentrated and were high in TDS and Hardness. Inhibition of seed germination may be due to greater amount of dissolved solids that increases the salinity and conductivity of the absorbed solute by seed before germination moreover higher salt content also changes the osmotic potential outside the seed thereby reducing the amount of water absorbed by the seed which results in retardation of seed germination [4].

Seedling Development:
Root length and Shoot length (Table 3) showed considerable decrease recorded minimum up to 15.8% (1.03cm) and 13.0%(0.74cm) respectively in W13as compared to control with (6.48cm and 5.65cm respectively) followed by W7 34.10% (2.21cm) and 55.39% (3.13cm) , W8 41.66% (2.70cm) and 62.83% (3.55cm) and W9 50.15% (3.25cm) and 61.94% (3.5cm). Less severe results were obtained in W6 (6.03 cm and 6.04 cm), W16 (5.95 cm and 6.27 cm), W15 (4.74 cm and 6.47 cm) and W2 (5.43cm and 4.60 cm). Samples W6, W16, W15and W2 were groundwater from North Bagru, groundwater from South of Bagru, wastewater with lower concentration respectively. As they contains essential nutrients over distilled water which was taken as control. Therefore, W16 and W6 showed shoot length more than that of control. Effluent application does not affect significantly affect dry weight of seedling. Fresh Weight of seedling (Table 3) was recorded minimum in W13 8.64 %(0.111g) followed by W7 24.42 %(0.3138g) and was recorded maximum in W16 96.06 % (1.2340 g).

Vigor Index and Tolerance Index:
Vigor Index (Fig 3) and Tolerance Index (Fig 4) of seedlings were minimum in W13 (65.73and 0.15 respectively) followed by W7 (250.36 and 0.33) and W8 (0.41 and 4.8) respectively. Maximum Tolerance Index and Vigor Index were recorded in W11 (946.66 and 0.92) followed by W16 (8.15 and 855.8) and W6 (6.85 and 765.66). Percentage Phytotoxicity (Fig 2) was high in W13 (83.99%) followed by W7 (65.89%) and W8 (58.20%). Minimum phytotoxicity was observed in W6 (6.84%) followed by W16 (8.17%). The phytotoxicity caused by textile effluents results from intoxication of living tissues by substances accumulated from the growth medium [23]. Higher concentration of effluent decreases activities of enzyme dehydrogenase [24] and acid phosphatase [25] which can be considered as those various biochemical changes which may interrupt germination and seedling growth and involved in mobilization of nutrient reserves [26]. The increase salinity level is responsible for decreasing seed characteristics [27] as salinity delays plant growth under reduction of photosynthesis effects, due to closing stomata and reduction of water entrance into the plant and ultimate effect on duplicate reduction in plant weight [28] Moreover, findings indicate that textile wastewater was rich in heavy metals and heavy metals had antagonistic effect on essential plant nutrient uptake [7].

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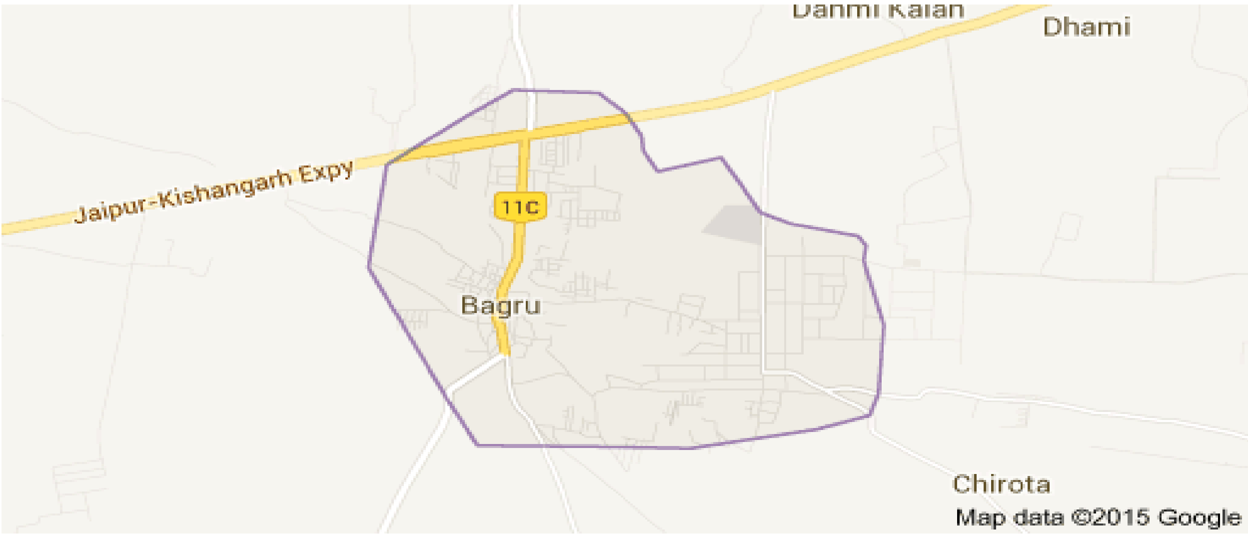

Table 1: Chemical Analysis of Various textile wastewaters from Bagru (Rajasthan).

Parameter	Unit	Minimum	Maximum	Mean
pH	-	4.46	8.12	7.12
TDS	ppm	2320	9840	4046
EC	µS	3.51	15.07	6.16
Salinity	ppt	2.67	11.38	5.00
Hardness	mg/L	230	1740	557
Chloride	mg/ml	284	4650.5	1212

Table 2: Correlation among various parameters of chemical analysis

	pH	TDS	EC	Salinity	Hardness	Chloride
pH	1.00	-0.85	-0.86	-0.77	-0.87	-0.76
TDS		1.00	0.88	0.90	0.95	0.77
EC			1.00	0.90	0.94	0.72
Salinity				1.00	0.89	0.91
Hardness					1.00	0.76
Chloride						1.00

Table 3: Effect of Textile wastewater on seed germination and early growth of *T.aestivum* var HD 2932

Samples	Seed Germination % (after 48 hrs)	Root Length (cm)	Shoot Length (cm)	Fresh weight (grams)	Dry Weight (grams)
W1	50±8.1	4.90±0.91	4.45±0.5	0.7248±0.003	0.086±0.01
W2	66.6±4.71	5.43±0.58	4.6±0.1	0.8050±0.007	0.122±0.01
W3	56.66±12.47	4.26±0.22	4.74±0.04	0.9822±0.01	0.077±0.01
W4	60±8.1	3.36±0.079	4.57±0.06	0.9298±0.005	0.109±0.02
W5	63.33±4.71	4.5±0.32	4.91±0.06	0.7023±0.002	0.086±0.01
W6	63.33±9.42	6.03±0.12	6.04±0.05	1.0549±0.03	0.082±0.008

W7	46.66±4.71	2.21±0.14	3.13±0.1	0.3138±0.01	0.033±0.002
W8	80±0.0	2.70± 0.24	3.55±0.09	0.5334±0.02	0.10±0.02
W9	76.66±4.71	3.25±0.15	3.5±0.12	0.4691±0.006	0.047±0.01
W10	66.6±12.47	4.71±0.04	5.42±0.03	0.8094±0.008	0.094±0.02
W11	93.33±4.71	5.31±0. 15	4.82±0.1	0.8562±0.004	0.11±0.02
W12	70±8.1	4.09±0.61	4.49±0.0 5	0.5759±0.007	0.066±0.03
W13	36.66±4.71	1.03±0.1	0.74±0.05	0.111±0.002	0.020±0.01
W14	80±8.1	5±0.27	5.50±0.14	0.7914±0.003	0.080±0.001
W15	56.66±9.42	4.74±0.1	6.47±0.06	0.5701±0.002	0.06±0.01
W16	70±0.0	5.95±0.1	6.27±0.06	1.2340±0.02	0.1±0.02
Control	100±0.0	6.48±0.01	5.65±0.04	1.2845±0.01	0.11±0.02

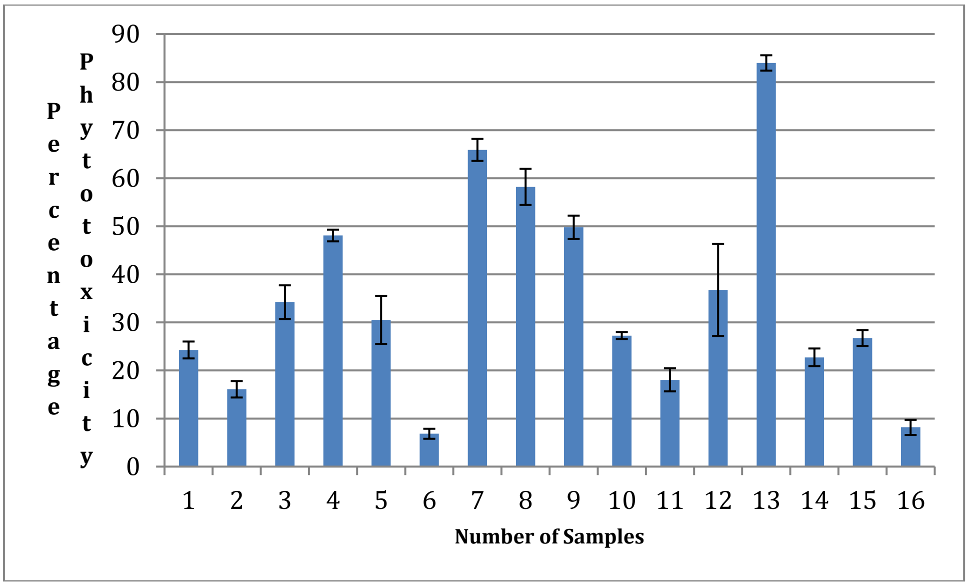

Fig 2: Effect of textile wastewater on % phytotoxicity of *T. aestivum*

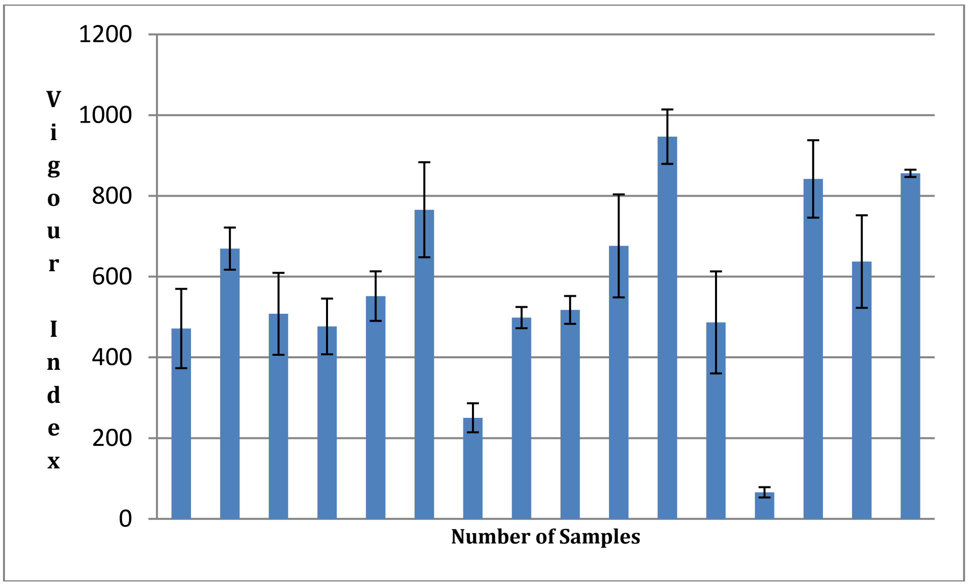

Fig 3: Effect of textile wastewater on Vigour Index of *T. aestivum*

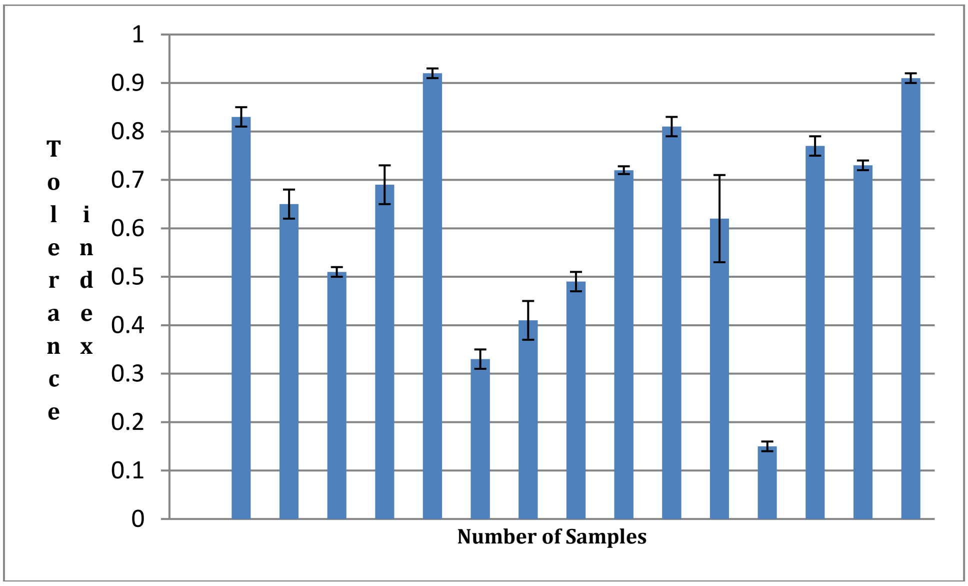

Fig 4: Effect of textile wastewater on Tolerance Index of *T. aestivum*

Fig 1. Water samples collected from Different textile region of Bagru (Rajasthan)

CONCLUSION:

Health gets affected by what one eat therefore good quality nutritious food is essence for health .Quality of water used for irrigation affects growth, development and nutrient value of crops. Textile wastewater samples are found generally rich in hardness, total dissolved solids, chloride and other heavy metals. However, the effects of textile effluent on plants depend upon type of species and types and concentrations of toxic materials in effluent;

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therefore a scientific study is required before any waste can be used for irrigation for a specific crop. Samples exceeding the permissible limits showed poor results in terms of growth and seedling development of, diluting them can minimize the effect, but further treatment is recommended for agriculture purpose. Groundwater results showed that it is unaffected, healthy and is suitable for drinking and agriculture.

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